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The predictive role of sonographic clavicular length for cesarean section for labor arrest in nulliparous pregnants at term

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Abstract

Aim: Fetal sonographic measurement of clavicle enables obstetricians to evaluate fetal growth, congenital anomalies and shoulder dystocia. In this study, we aimed to determine the role of clavicular length obtained in the latent phase of labor to predict cesarean section for labor arrest in nulliparous term pregnancies.

Material and Methods: From October to December 2019, 500 nulliparous term pregnants were included in the study, who were divided into two groups as vaginal delivery (n=441) and cesarean section (n=59). Sociodemographic characteristics, neonatal outcomes, obstetric features and clavicular length were compared between the two groups. Receiver operating curve analysis was performed to determine the predictive role of clavicular length for the cesarean section. The relationship between clavicular length and delivery features was examined by correlation analysis.

Results: There was no difference between the two groups in terms of age, body mass index, gestational week, birth weight, conjugata obstetrica, APGAR scores and neonatal intensive care unit admission rates. The clavicular length was 43.73±2.01mm in vaginal delivery and 45.1±1.73 mm in the cesarean group. The fetal clavicular length was longer in the cesarean section group compared with the vaginal group (p=0.040). The mean length of the second stage of labor was 29.20±23.93 minutes in the vaginal delivery group. In ROC analysis, the area under the curve for fetal clavicular length was 0.584 with a sensitivity of 79.7% and a specificity of 35% with a threshold value >43.45 milimeter and with p=0.040.The fetal clavicular length was correlated with the gestational week in all groups (r=0.752,p<0.001) and positively correlated with the length of the second stage of labor in the vaginal delivery group (r=0.566,p<0.001).

Discussion: The obstetric societies established guidelines for the management of labor arrest to reduce primary cesarean section rates. It is a challenging issue to determine the delivery mode in nulliparous pregnants, and we suggest that sonographic clavicular length could help obstetricians to predict labor arrest and cesarean delivery in nulliparous term pregnants.

Keywords

Cesarean section; Clavicular length; Labor arrest; Nulliparous; Sonography; Term

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Introduction

Cesarean section, which is performed on nearly 1.3 million pregnant women per year in the United States, is the most common surgical procedure in obstetric practice [1]. Cesarean deliveries are related to a high risk of uterine rupture and maternal complications in subsequent pregnancies, and a high infection risk when performed at low levels of the birth canal in a recent pregnancy [2]. Thus, choosing the optimal delivery mode and time is crucial for maternal and fetal well-being.

Previous studies have reported that labor arrest is the most common indication for primary cesarean section [3,4]. The arrest of labor, which is a challenging issue for obstetricians all over the world, is commonly followed by cesarean section and instrumental interventions that are tightly related to an increased risk of perinatal complications [5]. Maternal age, nulliparity, gestational week at delivery, birth weight, abnormal fetal head position, epidural anesthesia, macrosomia, and premature rupture of membranes are well-known indicators of labor arrest [6-8]. Defining the arrest of labor and deciding the optimal delivery mode has a great variability and is not clear enough in current guidelines. Although the Society of Maternal-Fetal Medicine and the American College of Obstetricians and Gynecologists have established guidelines for the management of labor arrest disorders to prevent primary cesarean section, only a mild decrement in cesarean rates was detected in 2015 [9,10]. Sonographic visualization of the fetal head, body and long bones enables obstetricians to evaluate fetal growth and congenital anomalies [11]. Moreover, sonographic measurements of those could be helpful in deciding on the delivery mode [12]. Recently, there have been several studies investigating the effect of intrapartum sonography by evaluating the fetal position and descent of the head to predict the mode of delivery [13,14]. The clavicle is an early ossified, horizontally placed bone of the human body [15]. It demonstrates a more linear growth pattern during the intrauterine period, thus it could be used to estimate gestational age. Another feature of this bone is the relationship between the ossification and the syndromes such as Holt Oram, cleidocranial dysplasia, Goltz and Melnick Needles. Furthermore, clavicular length, the representative of shoulder width, claimed to be a reliable marker for shoulder dystocia [16-18]. In a previous study, the fetal clavicular length was found to be significantly and strongly correlated with estimated fetal weight, biparietal diameter, abdominal circumference and femur length [19]. There is no data in the literature about the intrapartum sonographic clavicular length. Here, we primarily aimed to evaluate the role of sonographic measurement of clavicular length, obtained in the latent phase of labor, for predicting cesarean section for the arrest of labor in nulliparous women at term.

Material and Methods

This is a prospective study that was performed at a large-scale university-affiliated research and training hospital between October and December 2019. It was approved by the local ethics committee of our center with a decision number 2011-KAEK-25 2019/10-01 and it was in accordance with the Declaration of Helsinki. Written informed consent was obtained from all study participants.

Study Population

A total of 650 pregnant women were initially included in the study. The study groups were composed of nulliparous term pregnant women who were admitted to our delivery room and gave birth in our hospital. The exclusion criteria in our study were as follows: multiple pregnancies, preterm birth, nonvertex presentation, history of previous uterine surgery, intrauterine fetal death or fetal anomalies, macrosomia, premature rupture of membranes, and oligohydramnios. After patients were selected according to the inclusion and exclusion criteria, 591 pregnant women were followed up during labor.

The sociodemographic features such as age, gravida, gestational age at delivery, height and weight were recorded. Body mass index (BMI) was calculated by dividing weight by the square of height.

In the latent phase of the labor, the clavicular length was measured for each participant. The measurement was made as follows: at axial planning, the clavicles including the curvature and configuration were determined. The calipers were placed on the sternal and acromial ends of the clavicle. The maximum distance was measured three times in each patient and the mean value was recorded. All sonographic measurements were obtained by the same sonographer who was blinded to the patients' characteristics.

In the delivery room, the results of the vaginal examination, including fetal head station, cervical dilatation and effacement, were recorded to evaluate the progression of the labor. The decision on the mode of delivery was made by the specialist in the delivery room, independently from the researcher. Then, 91 pregnants underwent cesarean section for any reason other than the arrest of labor, and they were excluded from the study. The remaining 500 patients were divided into two groups as vaginal delivery (n=441) and cesarean section (n=59). Sociodemographic characteristics, birth weight, APGAR scores of the first and fifth minutes of neonates, neonatal intensive care unit admission, and clavicular length were compared between the two groups.

Statistical Analysis

The sample size of the study was calculated using power analysis with 80% power and 30% difference and α-value of 0.05 as 350. The Shapiro-Wilk test was carried out to determine whether continuous variables were normally distributed or not. Continuous variables were expressed as mean±standard deviation or median (minimum-maximum), whereas categorical variables were expressed as frequency and percentage. The independent t-test was used to compare two groups for normally distributed variables, the Mann-Whitney U test for non-normally distributed variables and the chi-square test or Fisher's exact test for categorical variables. Receiver operating curve (ROC) analysis was performed to determine the predictive role of clavicular length for cesarean section. The relationship between the clavicular length and the delivery features was examined using Spearman correlation analysis. An α-value ≤0.05 was considered statistically significant. The statistical analysis of the study was performed with SPSS software, version 21.0 (IBM Corp. Released 2012. IBM SPSS Statisticsfor Windows, Armonk, NY, USA).

Results

The mean age of the patients included in the study was 22.47±4.0 years, and the mean BMI was 30.21±2.27 kg/m^2. The median gestational age at delivery was 39 (37-42) weeks, while the mean birth weight of the babies was 3204.23±449.66 grams.

The patients were divided into two subgroups as vaginal delivery (n=441) and cesarean section (n=59). There was no statistically significant difference between the vaginal delivery and cesarean section groups in terms of age, BMI, gestational age at delivery, birth weight, conjugata obstetrica, first- and fifth-minute APGAR scores, and neonatal intensive care unit admission rates. The fetal clavicular length was 43.73± 2.01 mm in the vaginal delivery group, whereas it was 45.1± 1.73 mm in the cesarean section group. The fetal clavicular length was significantly longer in the cesarean section group compared with the vaginal delivery group (p=0.040). The features of the groups are demonstrated in Table. The mean length of the second stage of labor was 29.20 ± 23.93 minutes in the vaginal delivery group.

Table. The characteristics of the patients in the vaginal delivery and cesarean section groups

	Vaginal Delivery Group (n=441)	Cesarean Section Group (n=59)	p
Age (years)	22 (16-38)	21 (16-37)	0.561
BMI (kg/m2)	30.11 ±2.27	31.63 ± 1.78	0.070
Gestational age at delivery (week)	39 (37-42)	39 (37-40)	0.149
Birth weight (gram)	3104.7 ± 450.3	3250.8 ± 380.5	0.051
Conjugate obstetrica (mm)	9.73 ± 0.57	10.7 ± 1.01	0.060
APGAR score at first minute	9 (8-9)	9 (7-9)	0.080
APGAR score at fifth minute	10 (9-10)	10 (8-10)	0.078
NICU admission (n,%)	3 (0.68%)	1 (1.69%)	0.234
Fetal clavicular length (mm)	43.73 ± 2.01	45.1 ± 1.73	0.040

BMI: Body mass index, NICU: Neonatal intensive care unit

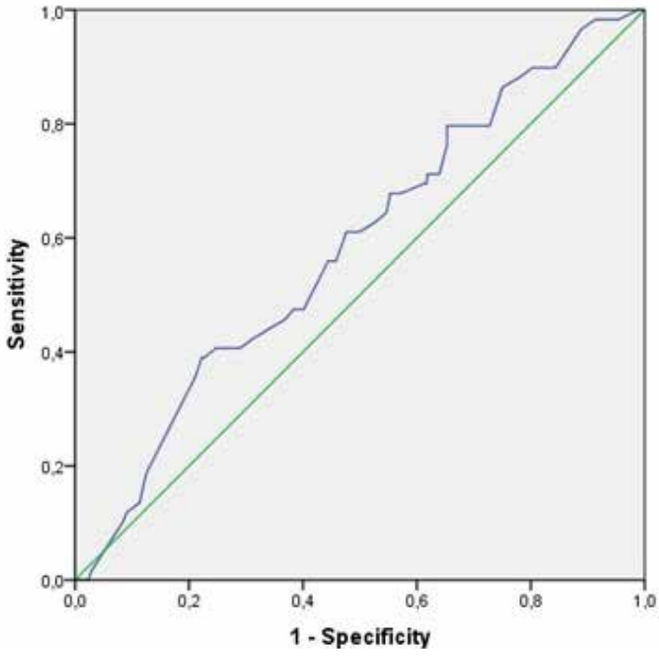

Figure 1. The Receiver-operator characteristic curve of fetal clavicular length for predicting cesarean section

The predictive role of fetal clavicular length for the cesarean section was evaluated using the ROC curve. The area under the curve (AUC) for fetal clavicular length was 0.584 with a sensitivity of 79.7% and a specificity of 35% with a threshold value >43.45 mm with a p-value of 0.040 (Figure 1).

Another finding of the study is the correlation between fetal clavicular length and obstetric parameters. In all groups, fetal clavicular length was found to be significantly correlated with the gestational week (r=0.752, p<0.001). Moreover, it was positively correlated with the length of the second stage of labor in the vaginal delivery group (r=0.566, p<0.001).

Discussion

In the present study, we found that fetal clavicular length was significantly longer in the cesarean section group compared with the vaginal delivery group. Moreover, the fetal clavicular length was determined to be a predictor with a cut-off value >43.45 mm with a sensitivity of 79.7% and a specificity of 35% for cesarean section, and it was correlated with the gestational week in all study groups, and also it was positively correlated with the length of the second stage of labor in the vaginal delivery group.

There is limited information in the literature on the problem of measuring fetal long bones. Although computerized tomography is a gold standard technique for measuring long bones, the major limitations of this procedure are the radiation effect, time-consuming features and not being cost- effective [20]. Thus, new effective methods to measure long bones have been introduced, one of which is sonography. Sonographic fetal long bone measurement can be a marker to evaluate fetal growth and inherited diseases [19,21].

The clavicle, a bone of the shoulder girdle, is one of the fetal bones used in sonography to follow fetal growth. Ossification of the clavicula begins at the fifth and sixth week of fetal life before all other bones [22]. The measurement of the clavicle is useful not only in obstetrics, but also in archeological and orthopedic studies. In archeology, it can be used to determine age, sex, ethnicity, and posture of the body [23]. In orthopedics, clavicular shortening of more than 2 centimeter is accepted as an indicator of clavicular fractures [24,25].

In obstetrics, the clavicular length was found to be an indicator of shoulder width and gestational age. Hence, studies have been focused on the reliability of clavicular length for predicting osseous congenital anomalies, macrosomia and shoulder dystocia [16,19,23].

Cleidocranial dysplasia, Goltz Syndrome, Holt-Oram syndrome and Melnick Needles syndromes are some of the congenital syndromes, including clavicular pathology [19,21]. Holt-Oram syndrome includes clavicular shortening and defects in the limbs and cardiovascular system [17]. Cleidocranial dysplasia is a disease composed of clavicular aplasia, brachycephaly, and cranial defects, while Goltz syndrome consists of clavicular aplasia accompanied by skin anomalies, teeth hypoplasia, dystrophia of nails, and syndactyly. In Melnick -Needles syndrome, largely extended skeletal abnormalities, such as clavicular shortening, narrowed thoracic cage, curtsy in radius and tibia, and small facial bones, are present [18]. Since the prevalence of these syndromes is rare, the measurement of

clavicular length has been used in other fields of obstetrics.

The first study evaluating the relationship between fetal clavicular length and obstetric parameters was performed by Yarkoni et al in 1985. They reported a linear correlation between clavicular length and gestational age and defined 1 mm equals to 1 week rule. Moreover, they suggested that it could be used in determining the congenital anomalies affecting the bones and macrosomia leading to shoulder dystocia or labor arrest. In the same study, the clavicular length was found to vary between 33-43 mm at 37 weeks of gestation and 36-46 mm at 40 weeks of gestation [16]. Similar to the previous study, the fetal clavicular length was found to be significantly correlated with the gestational week in all groups in our study. In a study of Sherer et al., the clavicular length was longer than the measurements achieved by Yarkoni et al. and was shown to vary with the logarithm of gestational age. They suggested that rule that 1 mm equals to 1 week is inconsistent and results in the overestimation of gestational age nearly 6 weeks. In this study, the clavicular length was found to vary between 38.4-47.2 mm at 37 weeks of gestation and 41.9-52 mm at 42 weeks of gestation [19]. The clavicular length of our patients was consistent with previous studies.

Macrosomia is another concern associated with clavicular length in previous studies. In macrosomic fetuses, it was thought that the shoulder girdle would be greater [21]. Sherer et al. did not found any difference between diabetic and nondiabetic patients in terms of clavicle length [19]. Furthermore, there are no data in the literature supporting the relationship between clavicular length, clavicular fracture, and shoulder dystocia. As a consequence, measuring the clavicular length is not recommended in all fetuses, but noting the presence and configuration is suggested [19]. In our study, we excluded macrosomic fetuses, thus we have no idea about the role of clavicular length in predicting shoulder dystocia in macrosomic fetuses.

There is no study assessing the relationship between clavicular length and delivery mode in nulliparous women. We searched for this association and found that the clavicular length was 43.73±2.01 mm in the vaginal delivery group and 45.1±1.73 mm in the cesarean section group, which was longer in the cesarean section group compared to the vaginal delivery group. Moreover, it was positively correlated with the length of the second stage of labor in the vaginal delivery group. Another interesting finding of the study was the predictive role of clavicular length for determining the cesarean section. Although it has a fair sensitivity and specificity, it has been found to be a significant predictor with a threshold value >43.45 mm for cesarean section.

Conclusion

Primary cesarean section rate is a focused issue by governments all over the world. Many studies have been performed and societies established guidelines for the management of labor arrest, which is the most common indication for a primary cesarean section to reduce primary cesarean section rates. As a consequence, it is too important to determine the delivery mode in nulliparous pregnants, and we suggest that sonographic clavicular length could help obstetricians to predict labor arrest and cesarean delivery in nulliparous term pregnants.

Study Limitations

The present study has some limitations. Firstly, it has a single-center design. Second, the clavicular length measurement is limited to term and nulliparous pregnants. Lastly, the nomogram of clavicular length for each ethnicity would be useful to claim that the length limit could predict a cesarean section for the Turkish population.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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